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TITLE: POLYMER COMPOSITE MATERIAL CONTAINING METAL PARTICLE OF NANOMETER-ORDER SIZE AND ITS MANUFACTURING METHOD
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ABSTRACT:

PROBLEM TO BE SOLVED: To provide a polymer composite material containing metal particles of nanometer-order size to be used as an optical, electrical or magnetic functional material by uniformly dispersing metal particles of nanometer-order size in a polymeric substance, and its manufacturing method.

SOLUTION: The manufacturing method of the polymer composite material containing metal particles of nanometer-order size comprises a step of dispersing on the molecular level at least one metal precursor in a matrix composed of a polymeric substance and a step of reducing the metal precursor to metal to fix by irradiating the matrix

containing the metal precursor dispersed on the molecular level with light rays. The polymer composite material is manufactured by the method.

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[JP,2002-179931,A]

Japanese (PDF)

File Wrapper Information

FULL CONTENTS CLAIM + DETAILED DESCRIPTION
TECHNICAL FIELD PRIOR ART EFFECT OF THE
INVENTION TECHNICAL PROBLEM MEANS
DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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Notes:

1. Untranslatable words are replaced with asterisks (****).
2. Texts in the figures are not translated and shown as it is.

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Dictionary: Last updated 11/18/2008 : Priority: 1. Chemistry / 2. Manufacturing/ Quality / 3. Industrial Products

CLAIM + DETAILED DESCRIPTION

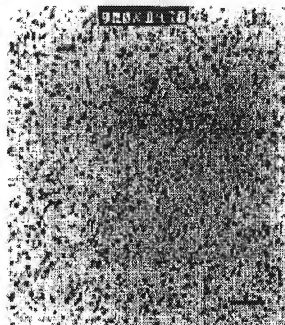
[Claim(s)]

[Claim 1] The stage of making the matrix accomplished with the polymer substance distributing a kind of metal precursor with the molecule level at least, The manufacture method of a polymer compound material that the metal grains of the nano unit size characterized by including the stage which irradiate light, and the matrix having contained the metal precursor distributed with the molecule level is made to return said metal precursor to a metal, and is made to fix to it were contained.

[Claim 2] The polymer substance which an electron will excite said matrix material if light is irradiated, and has $\pi \rightarrow \pi^*$ transition or the functional group in which it $n \rightarrow \pi^*$ transfers and an activity radical is formed, The manufacture method of a polymer compound material that the metal grains of the nano unit size according to claim 1 characterized by being with said polymer and any one sort in an inorganic substance with compatibility were contained.

[Claim 3] [said matrix material] The manufacture method of a

Drawing selection **Representative draw**



[Translation done.]

polymer compound material that the metal grains of the nano unit size according to claim 1 characterized by inner-choosing the copolymer containing the hetero atoms (heteroatom) containing the atom of a carbonyl group and isolated electronic countermeasure (lone-pair) structure and these functional groups were contained.

[Claim 4] As for said matrix material, the molecular structure is the manufacture method of a polymer compound material that the metal grains of the nano unit size according to claim 1 characterized by being the polymer structure as which any one sort was chosen at least among alignment, nonlinearity, the dendrimer, and the high PABU wrench polymer were contained.

[Claim 5] Said matrix material Polypropylene, biaxial extension polypropylene, Low density polyethylene, high density polyethylene, polystyrene, poly methyl methacrylic acid, Polyamide 6, polyethylene terephthalic acid, poly4 methyl 1 pentene, Polybutylene, the poly pentadiene, polyvinyl chloride, polycarbonate, Polybutylene terephthalic acid, ethylene propylene rubber, an ethylene butene propylene terpolymer, Poly oxazoline, PORIE pyrene oxide, polypropylene oxide, The manufacture method of a polymer compound material that the metal grains of the nano unit size of a description were contained in any 1 clause among Claim 1 or Claim 3 which are characterized by the thing for which polyvinyl pyrrolidone and those derivatives were inner-chosen, and which is any one sort at least.

[Claim 6] Said metal precursor is the manufacture method of a polymer compound material that the metal grains of the nano unit size according to claim 1 characterized by using the metal salt which can take out the ion of detailed metal grains were contained.

[Claim 7] Said metal precursor Au, Pt, Pd, Cu, Ag, Co, Fe, nickel, Mn and Sm, Nd, Pr, Gd, Ti, Zr, Si, In element, The intermetallic compound of said element (Intermetalliccompound), The alloy of two components in said element, the alloy of three components in said element, At least one of said elements is considered as an addition. The manufacture method of a polymer compound material that the metal grains of the nano unit size according to claim 1 characterized by being a kind at least among the metal salts chosen by the group accomplished with the oxide of Fe excluding the barium ferrite and the strontium ferrite with the implication were contained.

[Claim 8] Said light is the manufacture method of a polymer compound material that the metal grains of the nano unit size according to claim 1 characterized by using any one light among ultraviolet radiation and a visible radiation were contained.

[Claim 9] The quantity of said metal precursor is the manufacture method of a polymer compound material that the metal grains of the nano unit size according to claim 1 characterized by including

the quantity from 1:100 to 2:1 (metal mole: matrix functional group mole) by the molar ratio of the basic functional group unit of the polymer matrix to be used were contained.

[Claim 10] Whether the method of making a matrix distributing said metal precursor dissolves a matrix using a solvent or by carrying out melting, adding the compound containing a metal and said metal, and making said metal ionize The manufacture method of a polymer compound material that the metal grains of the nano unit size according to claim 1 characterized by making distribution uniform to a matrix distribute a metal precursor were contained.

[Claim 11] The polymer compound material with which the metal grains of the nano unit size characterized by being manufactured by the method of Claim 1 were contained.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the polymer compound material with which the metal grains of nano unit size were contained, and its manufacture method, and in more detail By distributing uniformly the metal grains which have size of a NANOMETA unit in a polymer substance, it is related with optical, the polymer compound material which was used as an electric and magnetic functionality material and with which the metal grains of nano unit size were contained, and its manufacture method.

[0002]

[Description of the Prior Art] In order for the grains of the metal which has size of a NANOMETA unit, or a semiconductor, i.e., a nano particle, (n-particles) to show the nonlinear optics effect generally, The composite material by which the nano particle is distributed by the polymer or the matrix (Matrix) of glass has captured the spotlight as an optical functionality material. Moreover, the nano particle which has magnetic characteristics is applied to many, such as being used as an electromagnetic storage medium.

[0003] As one example to manufacture, such a composite material Vacuum composure, sputtering (sputtering), CVD and sol -- the method of mixing the nano particle manufactured by the -**** method etc. with the polymer solution which melted and manufactured temperature to the polymer fusion or the suitable solvent raised and melted, and distributing in a polymer matrix is known.

[0004] [the existing nano particle dispersion matrix system] It was what it is hard to satisfy as a composite material, such as being easy to form a condensation thing when a nano particle is

distributed in a matrix, for example, setting using for nonlinear optics etc., and inducing light scattering with the change of state of an additional nano particle produced since the surface energy of a nano particle is high.

[0005] the characteristics of microscopic particles -- limited size (finite size) -- it has characteristics which are more different from massive voice operative. It is monodisperse [-like] and the trial for a valence to produce the metal grains of the nano meter size which is zerovalency has been performed through stable various physical variances, a scientific synthetic pathway, for example, sputtering, metal vacuum evaporation, polish, metal salt reduction, neutral organic metal precursor decomposition, etc.

[0006] Is the condensed powder form or the grains of transition metals, such as gold (Au) manufactured by the conventional method, silver (Ag), palladium (Pd), and platinum (Pt), tend to condense sensitively [the air] and in irreversible.

[0007] When there are a lot of substances, the problem of stability arises, and when it is a process, and an expensive air interception treatment procedure is not adopted and seal pavement of the final product is not carried out, such air susceptibility poses a problem in order to bring about the result which collapses by oxidation in the meantime.

[0008] Irreversible condensation of grains needs the special partition process for adjusting the size distribution of grains, and bars formation of an indispensable soft thin film to a magnetic recording applicable field etc. In addition, this floc decreases the surface area for a catalysis which is activity chemically, and restricts indispensable solubility to a biochemical label, separation, and a medicine transfer applicable field greatly.

[0009] For a Reason, it becomes an important target like the above to manufacture exact control of a grain dimension and a monodisperse nano particle in the technical applicable field of a nano substance. It is manufactured by mechanical polish, metal vacuum evaporation condensation, laser ablation (laser ablation), a physical method like electric spark corrosion, and the chemical method included reduction of the solution form voice of a metal salt, the pyrolysis of a metal carbonyl precursor, and electrochemical metal plating.

[0010] [a certain thing / the transfer fluid having contained the suitable stabilizer and the transfer fluid, or the suitable stabilizer] under existence of the metal grains accumulated from the steamy state among such physical or chemical processes At the time of a matrix and the process made to decode, since immiscible nature and permanent coherence arose, it was directly difficult to have made the existing technology improve to a required level.

[0011] Furthermore, it sets in the process distributed in a polymer matrix even if metal grains are manufactured in the shape of monodisperse difficulty [how]. It was difficult to have made the

existing technology improve to a required level by problems, such as coherence between compatibility with a polymer matrix, an interface defect (defects), or the grains that were manufactured.

[0012]

[Problem to be solved by the invention] Therefore, this invention took the problem of the Prior art into consideration like the above, and was thought out, and the purpose has a metal nano particle in offering the polymer compound material with which the metal grains of the nano unit size which maintains the state where it distributed without condensation eternal in a matrix uniformly were contained, and its manufacture method.

[0013] Other purposes of this invention are to offer the simple method that in situ ** of the individual process of the manufacture of grains and composite-izing which have nano unit size can be carried out, and said composite material can be manufactured easily. It is in the purpose of further others of this invention offering the method of conquering the limit of the amount of metal grain insertion in the existing compound material, and adjusting the amount of insertion of metal grains with the molecule level.

[0014]

[Means for solving problem] The stage where this invention makes the matrix accomplished with the polymer substance distribute the metal precursor more than a kind with the molecule level at least in order to attain the aforementioned purpose, Light is irradiated at the matrix having contained the metal precursor distributed with the molecule level, and the material manufactured by the polymer compound material manufacture method that the metal grains of the nano unit size characterized by including the stage to which it is made to return to a metal and said metal precursor is made to fix were contained, and this method is offered.

[0015] In said matrix, Au, Pt, Pd, Cu, Ag, Co, Fe, nickel, Mn and Sm, Nd, Pr, Gd, Ti, Zr, Si, In element, The intermetallic compound of said element (Intermetallic compound), [the precursor of the metal with which the group accomplished with the oxide of Fe which adds and contains at least one of said elements other than the alloy of two components in said element, the alloy of three components in said element, a barium ferrite, and a strontium ferrite was inner-chosen] by using melting or a solvent A metal precursor is made to be distributed with the molecule level uniformly by attraction with a matrix, and an in situ state is maintained.

[0016] [the matrix used in this invention] When the light which has the energy of a visible radiation (40 - 70 kcal/mole) and ultraviolet radiation (70 - 300 kcal/mole) is received, an electron is excited and a polymer, an inorganic substance with compatibility, etc. are included like the polymer which has the

functional group $\pi \rightarrow \pi^*$ transition or whose $n \rightarrow \pi^*$ transition is attained, or the above.

[0017] The conjugate (conjugate) electrons with which the double bond, the triple bond, or these which have an electron coexist if these are explained in detail will carry out $\pi \rightarrow \pi^*$ transition, if the energy of the wavelength of a 200-750nm field is absorbed. $N \rightarrow \pi^*$ transition of the functional group which has an isolated electronic countermeasure (lone-pair) like oxygen of a carbonyl group is attained.

[0018] If light is irradiated and electronic transition takes place, structure (conformation) will change or binding (bonding) will break. Although the wavelength value which causes the functional group to which transition takes place, and its transition was shown in the following table 1, this invention is not limited to this.

[0019]

[Table 1]

化合物	λ_{uv}	化合物	λ_{uv}
$\text{CH}_2=\text{CHCH}=\text{CH}_2$	217	$\text{CH}_2=\text{CO}-\text{CH}_3 (n \rightarrow \pi^*)$	270
$\text{CH}_2=\text{CHCHO}$	218	$\text{CH}_2=\text{CO}-\text{CH}_3 (\pi \rightarrow \pi^*)$	187
$\text{CH}_3\text{CH}=\text{CHCHO}$	220	$\text{CH}_3\text{COCH}=\text{CH}_2 (n \rightarrow \pi^*)$	324
$\text{CH}_3\text{CH}=\text{CHCH}=\text{CHCHO}$	270	$\text{CH}_3\text{COCH}=\text{CH}_2 (\pi \rightarrow \pi^*)$	219
$\text{CH}_3(\text{CH}=\text{CH})_2\text{CHO}$	312	$\text{CH}_2=\text{CHCOCH}_3$	219
$\text{CH}_3(\text{CH}=\text{CH})_3\text{CHO}$	343	$\text{CH}_3\text{CH}=\text{CHCOCH}_3$	224
$\text{CH}_3(\text{CH}=\text{CH})_4\text{CHO}$	370	$(\text{CH}_2)_4\text{C}=\text{CHCOCH}_3$	235
$\text{CH}_3(\text{CH}=\text{CH})_5\text{CHO}$	393	$\text{CH}_2=\text{C}(\text{CH}_3)\text{CH}=\text{CH}_2$	220
$\text{CH}_3(\text{CH}=\text{CH})_6\text{CHO}$	415	$\text{CH}_3\text{CH}=\text{CHCH}=\text{CH}_2$	223.5
$\text{CH}_2=\text{C}(\text{CH}_3)\text{C}(\text{CH}_3)=\text{CH}_2$	226	$\text{CH}_3\text{CH}=\text{CHCH}=\text{CHCH}_3$	227
$\text{Ph}-\text{CH}=\text{CH}-\text{Ph}(\text{trans})$	295	$\text{Ph}-\text{CH}=\text{CH}-\text{Ph}(\text{cis})$	280
Styrene	244, 282	Sulfide	~210, 230
C=O in carboxylic acid	200~210	Acid chloride	235
Nitrile	160	Alkyl bromid, iodides	250~260

If an electron is excited by light and binding breaks, the active substance of being radical will be generated, but this radical gives an electron to a metal ion, a metal ion returns, and it becomes a metal.

[0020] The matrix used in this invention Polypropylene, biaxial extension polypropylene, Low density polyethylene, high density polyethylene, polystyrene, poly methyl methacrylic acid, Polyamide 6, polyethylene terephthalic acid, poly4 methyl 1 pentene, Polybutylene, the poly pentadiene, polyvinyl chloride, polycarbonate, That as which polybutylene terephthalic acid, ethylene propylene rubber, an ethylene butene propylene

terpolymer, poly oxazoline, PORIE pyrene oxide, polypropylene oxide, polyvinyl pyrrolidone, and these derivatives were inner-chosen is used.

[0021] Moreover, [the functional group in which binding will break and a radical (Radical) will be formed if the polymer used as a matrix material absorbs light on the wavelength of an ultraviolet radiation-visible radiation (UV-VIS) field and an electron is excited] although a kind or the thing which it has two or more sorts can be used The group who has a carbonyl (carbonyl) machine and an isolated electronic countermeasure (lone pair) atom is the most desirable.

[0022] And the blend (blend) polymer which mixed two or more sorts of polymers which have the structure where the molecular structure of a polymer differs mutually among what has alignment, nonlinearity, a dendrimer, or high PABU wrench polymer structure, and the polymer which has the structure of said many can be used.

[0023] Although the quantity of said metal precursor is mole ** of the basic functional group unit of the polymer matrix to be used in this invention and accomplished including the quantity from 1:100 to 2:1 (metal mole: matrix functional group mole) If the ratio of a metal mole and a matrix functional group mole is smaller than 1:100 There is too little quantity of the metal grains contained in the polymer matrix, and the specific character of a metal-polymer is not shown. moreover, when the molar ratio becomes 2:1 or more, there is too much quantity of metal grains and a matrix is free -- standing (free-standing) -- it is because a film cannot be formed.

[0024] Although the structure of the composite material currently illustrated by drawing 1 is the film form by which silver (Ag) grains are uniformly distributed in the polymer matrix, it chooses a matrix [****] by the use of a composite material.

[0025] The matrix chosen as drawing 1 was polyvinyl pyrrolidone (Poly vinyl pyrrolidone), as for the metal precursor, AgBF₄ salt was chosen, and, as for the size of par grains, the nano particle of a number - tens of nm range was formed.

[0026] The composite material currently illustrated by drawing 1 may be manufactured as follows.

[0027] First, a matrix is melted to a solvent and the solution with which the matrix has untied the metal salt of the suitable ratio is distributed to the dissolution or homogeneity.

[0028] A matrix and a metal salt coat a base material (in this case, glass plate) with the solution distributed uniformly, and form a film. After removing a solvent and obtaining a free standing (free-standing) film, ultraviolet radiation is irradiated and the obtained film is made to return a metal salt to a metal.

[0029] Since a matrix is prevented from polymer condensing the

obtained composite material in metal salts, the size is constant and the composite material film of the form currently distributed per molecule can be obtained.

[0030] After the composite material by which the metal of existing NANOMETA grain size was distributed manufactures the metal grains of nano meter size, it is obtained by the method of distributing in a matrix.

[0031] [the existing method] even if grain distribution of nano meter size is acquired uniformly There was a problem which condensation of grains produces rather than each grain was uniformly distributed by conditions generated in the process distributed by the matrix in the case of the problem of the attraction between grains, and compatibility with a matrix, or a process, such as heat and a pressure.

[0032] In this invention, in order to make grains generate within the matrix by which the metal precursor is distributed with the molecule level by the in situ (inch-situ) method, there is an advantage from which metal matrix composite without a condensation thing (agglomeration) is obtained.

[0033] The composite material by this invention shows nonlinear optics characteristics by existence of a metal nano particle, and becomes possible [using as one element for adjusting the phase, strength, or frequency of light]. In addition, the content of a metal nano particle is high and the susceptibility of a light element is increased. It is known that this is the characteristics of nano metal composite without a condensation thing.

[0034] Since the film with which each quantity differed can be made, if the distance between the metal nano particles which adjoined the thickness of the field containing a proper nano particle is adjusted to conformity, it can use for conformity as a diffraction grating to the radiation which has the wavelength which ****s on X-lines from a far ultraviolet ray. Moreover, it becomes possible [also using as a data storage medium using a metalead magnetic property].

[0035] By adjusting the character of a matrix, in addition, the nonlinear Narimitsu study effect of a metal nano particle and characteristics of a matrix (For example, electrical conductivity) etc. -- it can use for various kinds of application fields to be used, and when a metal nano particle has catalytic activity, a catalyst component can use a composite material as a catalyst supported by the heat-resistant matrix.

[0036]

[Mode for carrying out the invention] In the following work example, this invention is explained in detail.

[0037] 1. Melt a work example 1 - 4Poly (2-ethyl-2-oxazoline) (POZ; molecular weight 5x105, Aldrich products) to 20weight % in water, and manufacture a polymer solution.

[0038] The molar ratio value of the molar ratio pair Ag salt of

carbonyl (carbonyl) which is the fundamental unit of POZ adds AgCF₃SO₃ set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level. After coating the thickness of 200 Å with the manufactured polymer-silver salt solution on a glass plate, a solvent is removed and a polymer-silver halide film is manufactured.

[0039] The manufactured polymer silver halide film is irradiated with an ultraviolet ray lamp in the air. The degree of electric surface conduction to each sample was measured, and the value was shown in the following table 2. In addition, plasmon peak (plasmon peak) perceived for metal grains was measured using the ultraviolet radiation-visible radiation (UV-VIS) spectrometer, and this was shown in [drawing 2](#).

[0040]

[Table 2]

	紫外線照射時間 (hr)	表面イオン伝導度 (Ω/cm)
比較例 1	0	0
実施例 1	2	0.007
実施例 2	3	0.007
実施例 3	5	0.008
実施例 4	7	0.01

[0041] 2. Melt a work example 5 - 6Poly (2-ethyl-2-oxazoline) (POZ; molecular weight 5x10⁵, Aldrich products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) which is the fundamental unit of a polymer adds AgCF₃SO₃ set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0042] The manufactured polymer-silver salt solution is coated with a thickness of 200 micrometers on a glass plate, a solvent is removed, and a polymer-silver halide film is manufactured. The manufactured polymer-silver halide film is irradiated with an ultraviolet ray lamp in nitrogen. The degree of electric surface conduction to each sample was measured, and the value was shown in the next table 3. Moreover, plasmon peak (plasmon peak) detected by metal grains was measured using the ultraviolet radiation-visible radiation (UV-VIS) spectrometer, and this was shown in [drawing 3](#).

[0043]

[Table 3]

	紫外線照射時間(hr)	表面イオン伝導度(Ω/cm)
比較例 1	0	0
実施例 5	3	0.006
実施例 6	7	0.008

[0044] 3. Melt work-example 7Poly (2-ethyl-2-oxazoline) (POZ; molecular weight 5x105, Aldrich products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgCF₃SO₃ set to 10:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0045] The manufactured polymer-silver salt solution is coated with a thickness of 200 micrometers on a glass plate, a solvent is removed, and a polymer-silver halide film is manufactured. The manufactured polymer-silver halide film is irradiated with an ultraviolet ray lamp in the air, and a compound thin film is manufactured.

[0046] 4. Melt work-example 8Poly (2-ethyl-2-oxazoline) (POZ; molecular weight 5x105, Aldrich products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgCF₃SO₃ set to 4:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0047] A compound thin film is manufactured by a method like said work example 1 using the manufactured polymer-silver salt solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 10nm and was uniformly distributed without floc.

[0048] 5. Melt work-example 9Poly (2-ethyl-2-oxazoline) (POZ; molecular weight 5x105, Aldrich products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgBF₄ set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0049] A compound thin film is manufactured by a method like said work example 1 using the manufactured polymer-silver salt solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 9nm and was uniformly distributed without floc.

[0050] 6. Melt work-example 10Poly (2-ethyl-2-oxazoline) (POZ; molecular weight 5x105, Aldrich products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgNO₃ set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0051] A compound thin film is manufactured by a method like

said work example 1 using the manufactured polymer-silver salt solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 10nm and was uniformly distributed without floc.

[0052] 7. Melt work-example 11 Poly (2-ethyl-2-oxazoline) (POZ; molecular weight 5x105, Aldrich products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgClO₄ set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0053] A compound thin film is manufactured by a method like said work example 1 using the manufactured polymer-silver salt solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 9.5nm and was uniformly distributed without floc.

[0054] 8. Melt work-example 12 polyvinyl pyrrolidone (Poly vinyl pyrrolidone and PVP; molecular weight are 1x106 and Polyscience products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgCF₃SO₃ set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level. A compound thin film is manufactured for the manufactured polymer-silver salt solution by a method like said work example 1 on a glass plate.

[0055] 9. Melt work-example 13 polyvinyl pyrrolidone (Poly vinyl pyrrolidone and PVP; molecular weight are 1x106 and Polyscience products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgBF₄ set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0056] A compound thin film is manufactured by a method like said work example 1 using the manufactured polymer-silver salt solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 9.5nm and was uniformly distributed without floc. A result has the structure shown in [drawing 1](#).

[0057] 10. Melt 14 to work-example 17 polyvinyl pyrrolidone (Poly vinyl pyrrolidone and PVP; molecular weight are 1x106 and Aldrich products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgBF₄ set to 2:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0058] The manufactured polymer-silver salt solution is coated on a glass plate, ultraviolet radiation is irradiated by time by a method like said work example 1, and a compound thin film is manufactured. The size of the silver manufactured in the polymer

matrix is carrying out the form which is an average of 9.5nm and was uniformly distributed without floc. The degree of surface conduction to each sample was shown in the next table 4.

[0059]

[Table 4]

	紫外線照射時間(hr)	表面イオン伝導度(Ω/cm)
比較例 2	0	0
実施例 1 4	0.17	9×10^{-3}
実施例 1 5	0.5	5×10^{-4}
実施例 1 6	1.75	2.37×10^{-3}
実施例 1 7	4	3.37×10^{-3}

[0060] 11. Melt work-example 18 polyvinyl pyrrolidone (Poly vinyl pyrrolidone and PVP; molecular weight are 1×10^5 and Aldrich products) to 20weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgBF₄ set to 4:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0061] A compound thin film is manufactured by a method like said work example 1 using the manufactured polymer-silver salt solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 10nm and was uniformly distributed without floc.

[0062] 12. Melt work-example 19 polyethylene oxide (Poly ethylene oxide; molecular weight 1×10^6 , Aldrich products) to 2weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of oxygen which is the fundamental unit of a polymer adds AgBF₄ set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0063] A compound thin film is manufactured by a method like said work example 1 using the manufactured polymer-silver salt solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 10nm and was uniformly distributed without floc.

[0064] 13. Melt work-example 20 polyethylene oxide (Poly ethylene oxide; molecular weight 1×10^6 , Aldrich products) to 2weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgBF₄ set to 4:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0065] A compound thin film is manufactured by a method like said work example 1 using the manufactured polymer-silver salt

solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 12nm and was uniformly distributed without floc.

[0066] 14. Melt work-example 21 polyethylene oxide (Polyethylene oxide; molecular weight 1x106, Aldrich products) to 2weight % in water, and manufacture a polymer solution. The molar ratio value of the molar ratio pair silver salt of carbonyl (carbonyl) adds AgCF_3SO_3 set to 1:1 in the manufactured solution, and it is made to distribute with the molecule level.

[0067] A compound thin film is manufactured by a method like said work example 1 using the manufactured polymer-silver salt solution. The size of the silver manufactured in the polymer matrix is carrying out the form which is an average of 10nm and was uniformly distributed without floc.

[0068] 15. Make Aqueous Solution so that HAuCl_4 May be Set to 8:1 by Molar Ratio on the basis of End Amine Group in Work-Example 22 3rd Generation Starburst (starburst) Dendrimer (Polyamide Amine; Molecular Weight 6909, Aldrich Products). This is mixed with the 20-weight % solution of polyvinyl pyrrolidone, gold salt is made to permeate in a dendrimer, a polymer is often mixed, a film is manufactured by the method of said work example 1, ultraviolet radiation is irradiated and a metal-polymer compound material is manufactured.

[0069] The gold which permeated the inside of a dendrimer is returned, since it was surrounded by the dendrimer, condensation of metals stops arising and the compound material constant [the] and distributed uniformly can be obtained.

[0070] The size of the gold grain inside the dendrimer measured through TEM is an average of 4nm, and is carrying out the form uniformly distributed without floc.

[0071] 16. Make [Work-Example 23 4th Generation Starburst (starburst) Dendrimer (Polyamide Amine; Molecular Weight 14279, Aldrich Products)] Aqueous Solution from Molar Ratio for HAuCl_4 to 8:1 on the basis of End Amine Group. This is mixed with the 20-weight % solution of polyvinyl pyrrolidone, gold salt is made to permeate in a dendrimer, a polymer is often mixed, a film is manufactured by the method of said work example 1, ultraviolet radiation is irradiated and a metal-polymer compound material is manufactured.

[0072] The gold which permeated the inside of a dendrimer is returned, since it was surrounded by the dendrimer, condensation of metals stops arising and the compound material constant [the] and distributed uniformly can be obtained.

[0073] The size of the gold grain inside the dendrimer measured through TEM is an average of 5nm, and is carrying out the form uniformly distributed without floc. Golden plasmon peak (plasmon peak) was measured for golden formation by ultraviolet radiation-visible radiation (UV-VIS) absorption spectrum, and the

result was shown in drawing 4.

[0074] 17. The compound material was manufactured by a method like said work example 1, using HAuCl_4 as a work-example 24 metal precursor. The size of the gold grain measured through TEM is carrying out the form uniformly distributed without floc at an average of 10nm.

[0075] 18. The compound material was manufactured by a method like said work example 1 using the metal salt which mixed HAuCl_4 and AgBF_4 with 1:1 molar ratios as a work-example 25 metal precursor.

[0076] 19. The compound material was manufactured by a method like said work example 1, using a FeCl_2 metal salt as a work-example 26 metal precursor.

[0077] 20. The compound material was manufactured by a method like said work example 1, using a CoCl_2 metal salt as a work-example 27 metal precursor.

[0078]
[Effect of the Invention] [this invention] while this invention accomplished like the above simplifies the double process which distributes the existing metal nano particle manufacture and a nano particle in a matrix Distribute the precursor of metal grains uniformly in a matrix with the molecule level, and the problem of the floc formation between the nano particles which are the problems of the existing composite material process is manufactured in the last form (mainly film form). A metal is made to return by light by in situ (in-situ) one, the size of grains can be adjusted by the used matrix and the compound material which condensation does not produce can be manufactured. Although the desirable work example of specification [this invention] was illustrated above as an example and explained to it, probably, various change and revision will be possible for this invention by those who have the usual knowledge in the technical field to which the invention concerned belongs within limits which are not limited to the aforementioned work example and do not deviate from the soul of this invention.

[Translation done.]

Report Mistranslation

Japanese (whole document in PDF)